Cardiac Assist

Education Materials

ACAT®1 PLUS

Intra-Aortic Balloon Pump

Timing, Triggering, and Troubleshooting

ARROW INTERNATIONAL

Arrow International
A*CAT*®1 PLUS Intra-Aortic Balloon Pump
Timing, Triggering and Troubleshooting

The Arrow ACAT®1 PLUS *Intra-Aortic Balloon Pump*

Part Number: A2H-TG, Revision 1

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Document Specification

When making reference to or requesting additional copies of this document, please note the following Part Number: A2H-TG, Revision 1.

Caution: U.S. Federal Law limits this device to sale by or on order of a physician. Contents of unopened, undamaged package are sterile. Disposable. Refer to package insert for current warnings, indications, contraindications, precautions, and instructions for use.

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1. Two Hour Program Schedule: A*CAT*®1 PLUS IABP

8:00 – 8:05	Registration and Welcome
8:05 – 8:30	Trigger Acquisition and Criteria
8:30 – 9:00	Timing
9:00 – 9:20	Utilizing the Balloon Pressure Waveform in Troubleshooting
9:20 – 9:35	Review of Common Alarm Situations
9:35 – 9:50	Set-up and Operation
9:50 – 10:00	Post test and Evaluation

2. Program Description

The primary focus of this two hour session is the technical aspects, operation and troubleshooting of the A*CAT*®1 PLUS Intra-Aortic Balloon Pump (IABP). Participants should have previous IABP experience and a sound working knowledge of the anatomy, physiology and theory of IABP therapy.

3. Program Objectives

1. Identify improper timing and appropriate corrective action.
2. Identify the most appropriate trigger signal selection for a given patient situation.
3. Identify the alterations that would occur in the balloon pressure waveform for two alarm conditions.
4. Demonstrate the set-up and operation of the IABP, utilizing the skills checklist.

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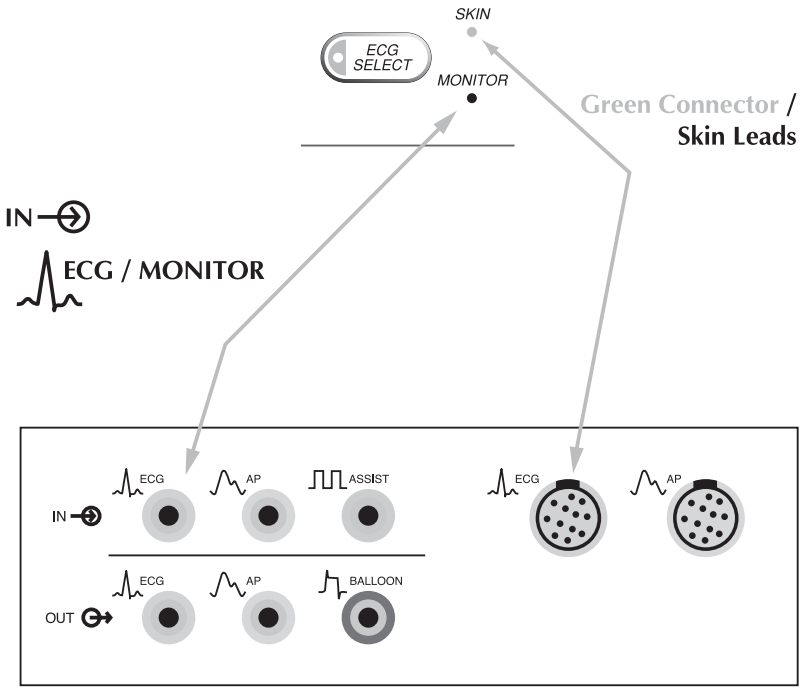
Patient Connections

1. ECG



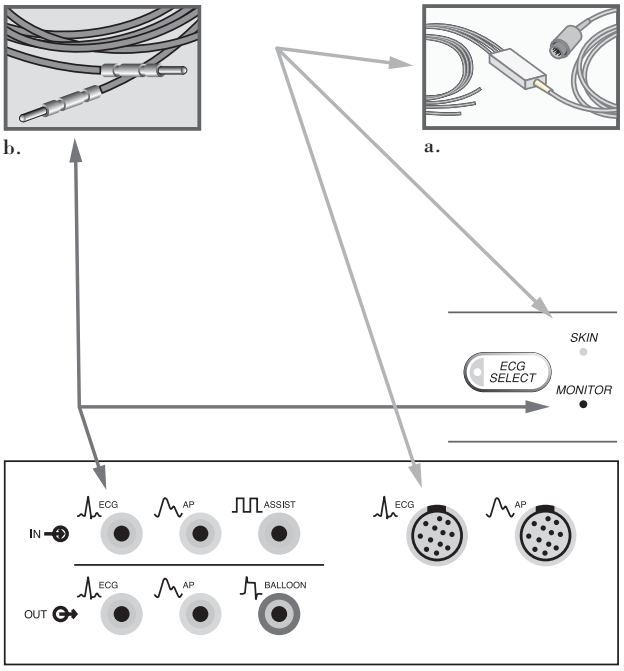
2. ECG Cables

a. Skin Leads Cable

1. Must have SKIN selected on keypad
2. For 3-lead cable choose I, II or III
3. For 5-lead cable choose I, II, III, aVR, aVL, aVF or V
4. Lead selected is highlighted in white

b. Phono to Phono Cable

1. Must have MONITOR selected on keypad
2. For monitor cables, actual lead choice is made at the monitor



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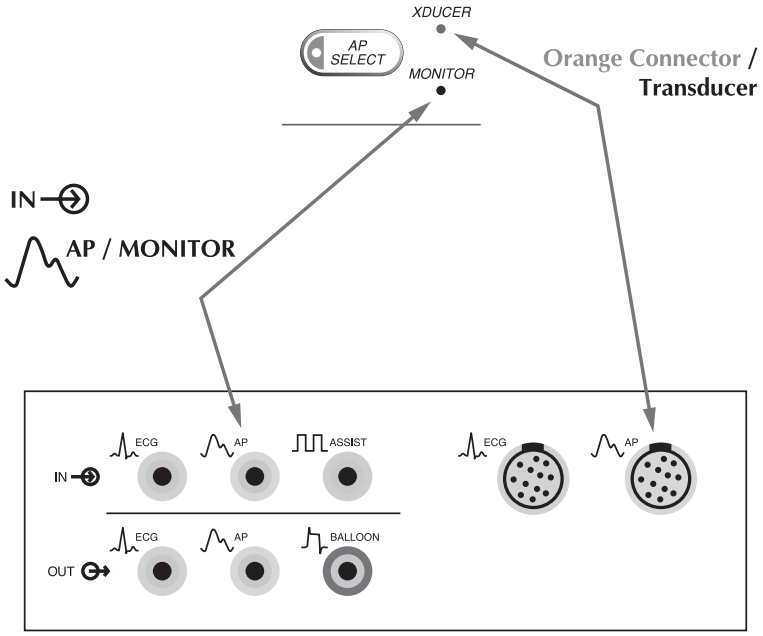
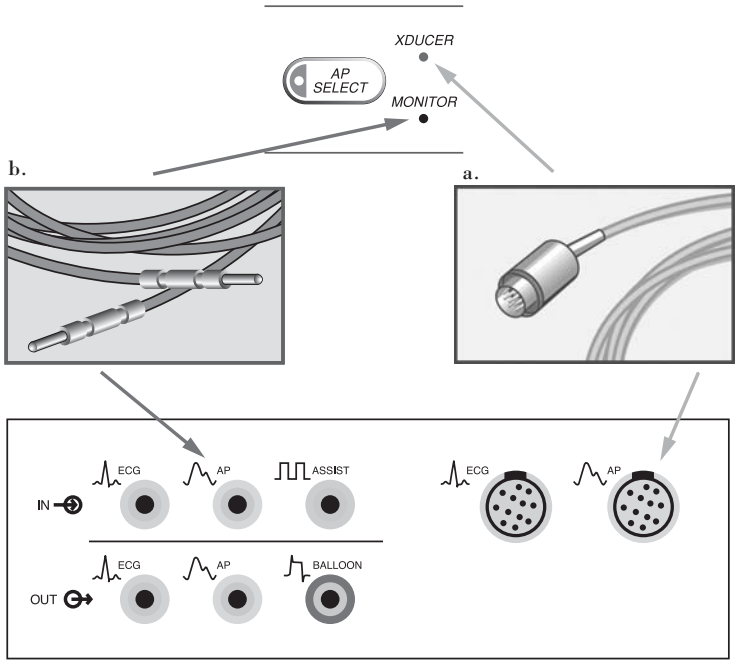
3. Arterial Pressure



4. AP Cables

a. Transducer Cable
- Must have XDUCER selected

b. Phono to Phono Cable
- Must have MONITOR selected



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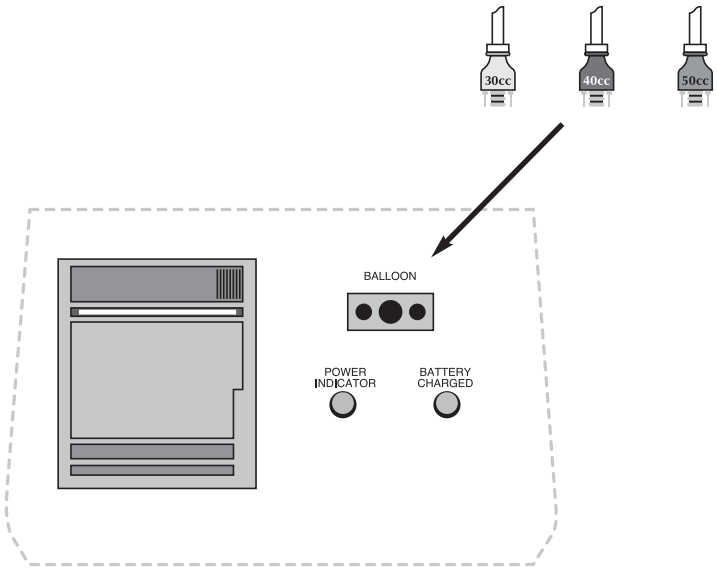
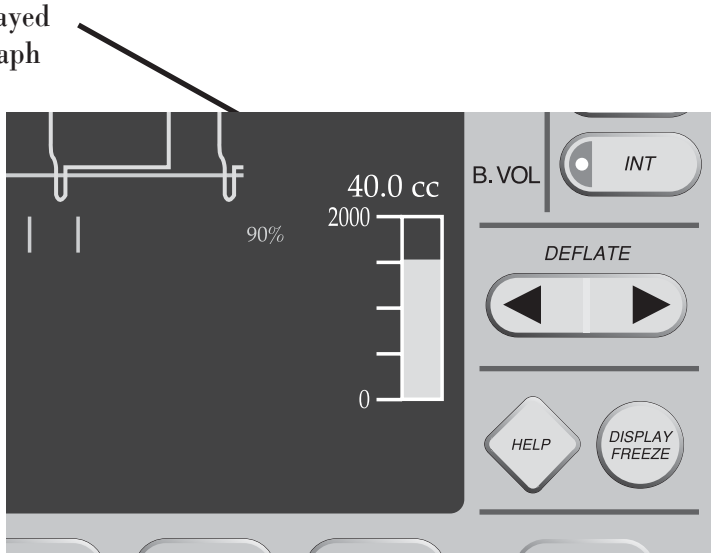
5. Balloon

a. Use a 30cc, 40cc or 50cc balloon

b. Push balloon connector in firmly, right side up or upside down - it does not matter



c. Balloon volume is displayed above the helium bargraph display.



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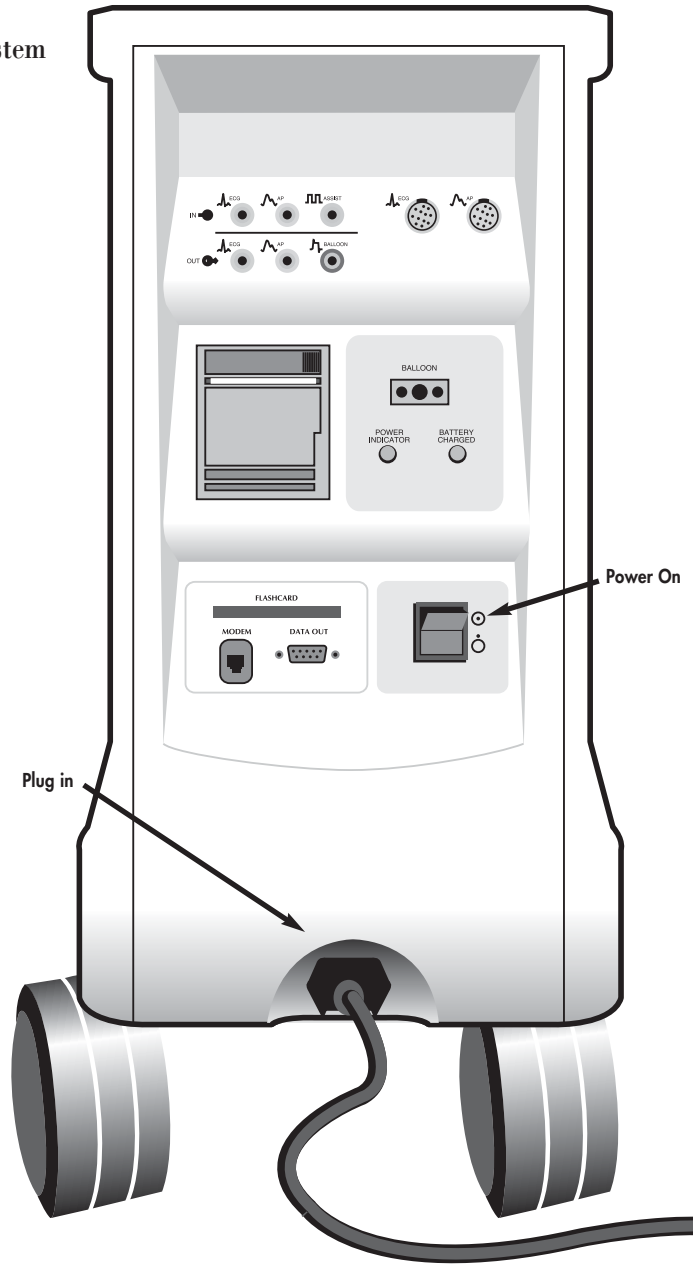
1. Power On

a. Applies power to the system



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2. Check:

3. Remember

a. The white overlay lines on the ECG and the Flashing Heart Symbol means the pump can see the Trigger that has been selected.

b. The console cannot pump without a Trigger. If no trigger, check to see if Trigger signal is present, check signal size, or change Trigger.

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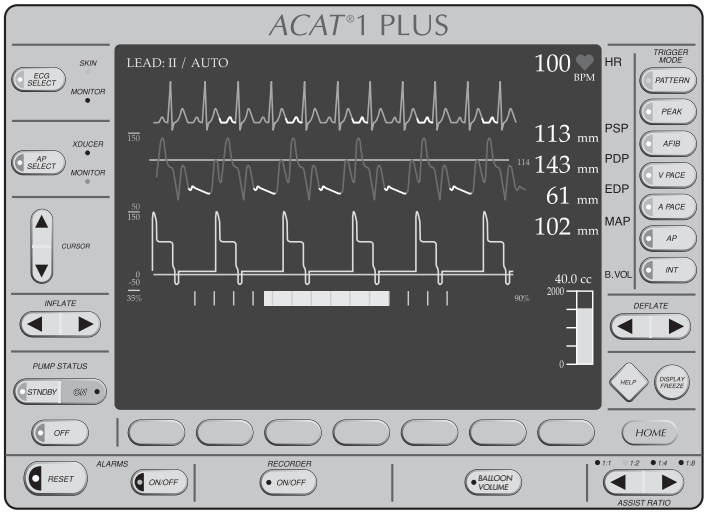
4. Initiate Pumping

a. Press STANDBY to activate 4 beat purge.

b. Then press ON to begin counterpulsation.

Alternately:

a. Press ON to purge once, fill, and initiate counterpulsation.



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5. Heart Pump Setup

An easy way to remember and complete the steps of setting up the A*CAT*®1 PLUS is to use the word HEART. Each letter stands for a step of set-up. Use of this method reduces the chance of incorrectly setting up the pump.

LETTER	SET UP STEPS
	Plug in pump and Power ON
H	**Check HE Display** BLUE: OK RED: OK but have an extra tank with the pump BLACK: Tank is OFF or empty. Turn tank ON or replace.
E	**ECG Set-up** Connect skin ECG cable or remote connection from bedside monitor Select or Verify ECG Source Select Lead
A	**Arterial Pressure Set-up (Optional)** Connect transducer or remote connection from bedside monitor Select or Verify AP Source Zero transducer
RT	**Reliable Trigger** Check for WHITE overlay on ECG trace. This should appear on every other ECG if assist ratio is 1:2. Otherwise, the WHITE overlay should match the assist ratio. The WHITE overlay should be between the R waves.
RT	**Relative Timing** Check the WHITE overlay on the AP. It will appear on every beat when the pump is OFF. Set inflation (beginning of WHITE overlay) at the dichrotic notch the deflation (end of the WHITE overlay) just prior to the next systolic upstroke.

Once these steps are complete, the pump is ready to start.

Connect the IAB and verify the volume setting.

Press PUMP ON to begin pumping.

Follow recommendations for timing and triggering described in this manual.

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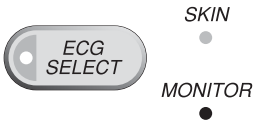
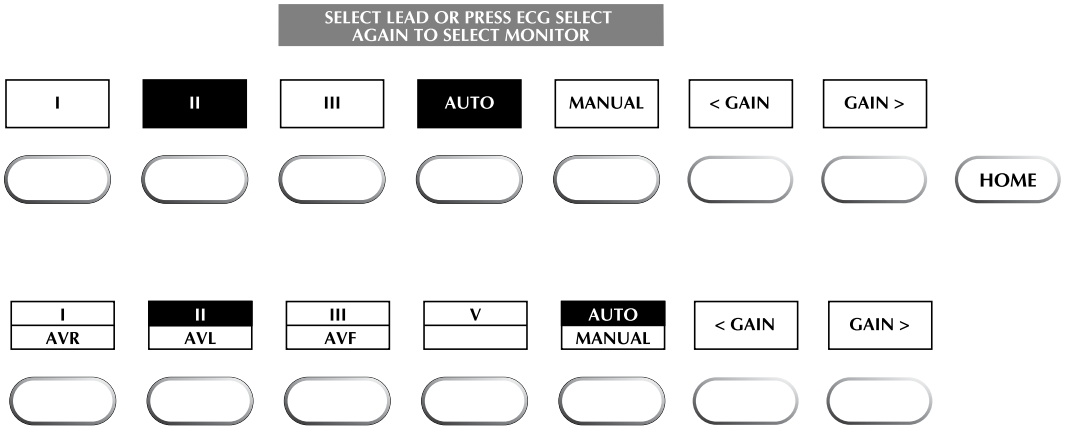
Information on the function of most keys can be obtained by pressing HELP, then pressing the key. For additional information, refer to the Operator's Manual.

1. ECG Select



a. ECG SELECT provides selection for LEAD, input source, gain mode and level.
   1. To change input source, press ECG SELECT twice.
   2. To change lead, press ECG SELECT once. Press key under desired LEAD label. To switch gain mode, press key under desired label. DECREASE/INCREASE GAIN keys can be used with AUTO or MANUAL GAIN. If AUTO is selected, the GAIN change is only valid until the lead is changed.



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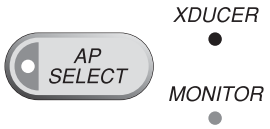
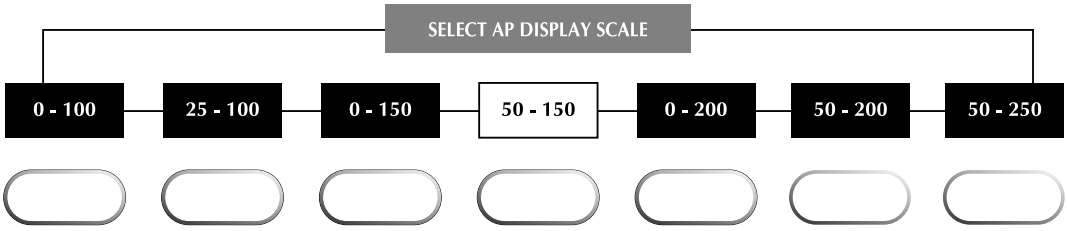
2. AP Select and AP Alarm (1.28 or higher software only)



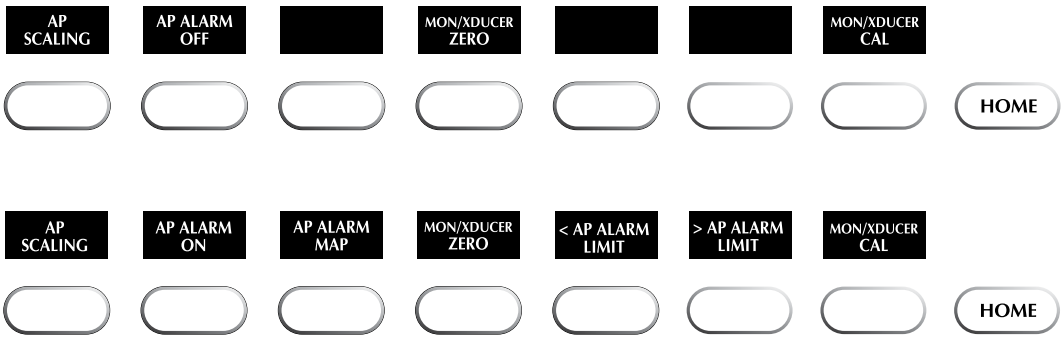
a. AP SELECT provides selection for source SCALE, ZERO, and CAL.

1. To change input source, press AP SELECT twice.
2. To adjust SCALE, ZERO or CAL, press AP SELECT once, then:
   - To change AP scale, press AP SCALING.
   - To zero, open transducer to air and press ZERO.



b. Setting AP ALARM (1.28 or higher)

1. Press AP SELECT
2. Press AP ALARM OFF. This will turn the alarm ON.
3. Select AP parameter for alarm. MAP or PDP.
4. Set alarm limit. Alarm limit can be adjusted in 5 mmHg increments.
   4.1. MAP pre-set alarm limit: 70 mmHg
   4.2. PDP pre-set alarm limit: 100 mmHg



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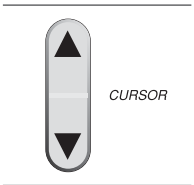
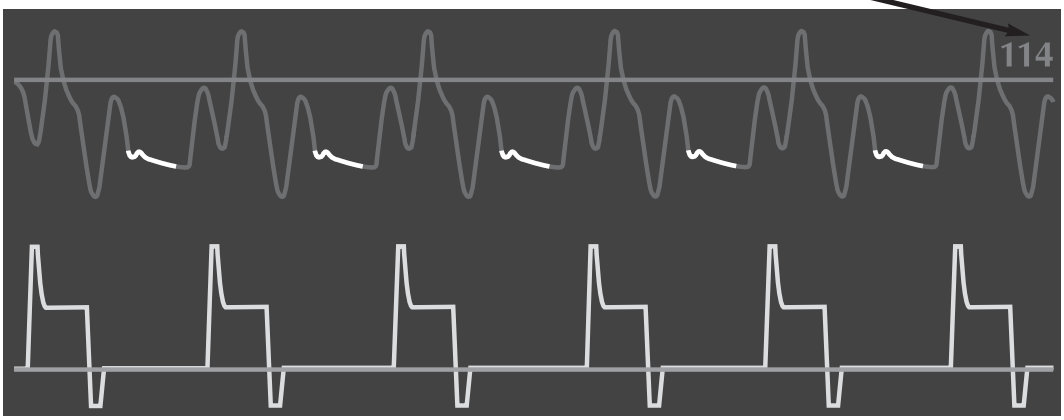
3. Cursor



a. Moves horizontal cursor on AP and BPW. Move cursor to desired assessment point. Value is displayed above cursor on the right hand side.



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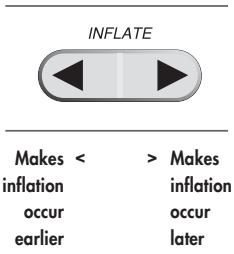
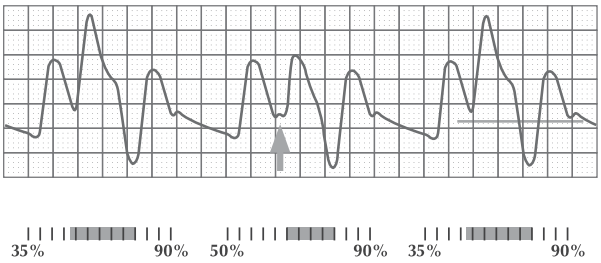
4. Inflate – Adjusts inflation point.

a. Inflation occurs earlier when the left arrow is depressed and later when the right arrow is depressed. Allows the operator to optimize timing by monitoring the hemodynamic changes produced on the AP waveform.



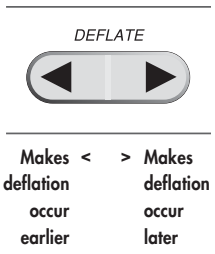
1. Move the inflation point to the right until you can clearly see the dicrotic notch on the arterial pressure waveform.
2. Slowly move the inflation point to the left until the dicrotic notch (40ms in front of AVC/DN) is no longer visible.



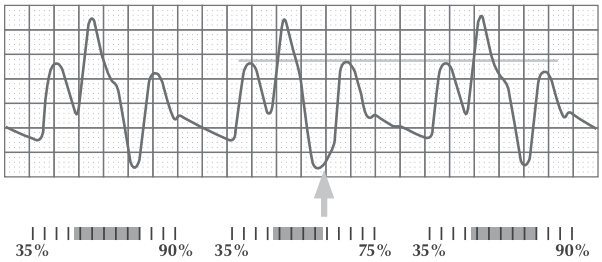
3. Check PDP/DA. Generally PDP/DA should be > APSP. If not, additional assessment of the patient or IABP may be required.

5. Deflate – Adjusts deflation point.

a. Deflation occurs earlier when the left arrow is depressed and later when the right arrow is depressed. Allows the operator to optimize timing by monitoring the hemodynamic changes produced on the AP waveform.



1. Move the deflation point to the left to see its effect on the AP waveform. Note the rise in the APSP and the plateau of the BAEDP/AEDP.
2. Move the deflation point to the right to lower the APSP while simultaneously keeping the BAEDP/AEDP lower than the PAEDP/UEDP.



3. Return the ASSIST RATIO to 1:1.

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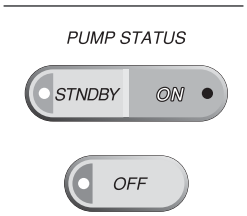
6. Pump Status



a. ON
Starts pumping.
If pressed before STNDBY, pumping starts after one purge cycle and the pneumatic system fills with helium to 2.5mmHg.

b. STNDBY
If pump is on, immediately stops pumping but does not vent the pneumatic system. If pump is off, completes a four beat purge cycle and pressurizes the pneumatic system with helium to 2.5mmHg. If pump left in STNDBY > 3 minutes an alarm will be issued.

c. OFF
Immediately stops pumping, deflates the balloon and vents the pneumatic system to atmosphere.
Six alarms automatically stop the pump.

7. Trigger Modes

a. Preset trigger. For normal QRS complex.Uses height, width and slope of positive or negative QRS complexes. Width must be between 25 and 135 msec. Rejects pacer spikes.

b. For any type of QRS complex and changing QRS shapes. Uses height and slope only of positive or negative QRS complexes. May be preferred for HR > 140. Rejects pacer spikes.

c. For irregular cardiac rhythms. Uses height and slope only of positive or negative QRS complexes with REAL TIME (R-Wave) deflation. Rejects pacer spikes.

d. Uses V-pacer spikes to trigger. MUST BE 100% PACED. For V and AV sequential pacers.

e. Uses A-pacer spikes to trigger. MUST BE 100% PACED. For Atrial pacers only.

f. Uses AP waveform to trigger. Recommended when ECG is not available or too noisy. NOT RECOMMENDED FOR IRREGULAR RHYTHMS.

g. Uses IABP internal signal for triggering. Used when no ECG or AP signal is available. ASYNCHRONOUS TO PATIENT CARDIAC ACTIVITY. Press INT twice to confirm.

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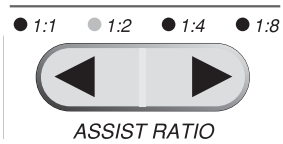
8. Assist Ratio



1:1 Initiates one inflation-deflation cycle for each cardiac cycle. Generally used after timing has been optimized.

1:2 Initiates one inflation-deflation cycle for every second cardiac cycle. Generally used to initiate counterpulsation, optimize timing, and to wean patient from IABP support. Is the preset assist ratio on power up.

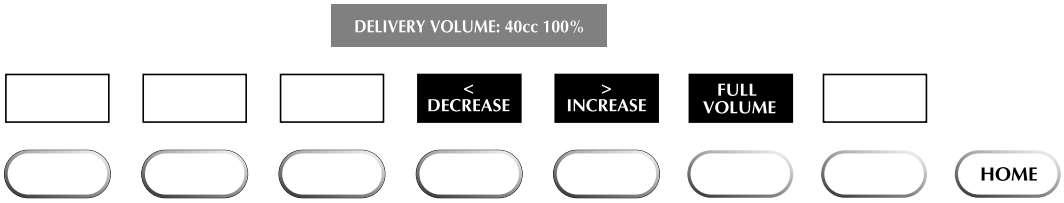
1:4 Initiates one inflation-deflation cycle for every fourth cardiac cycle. Generally used to wean patient from IABP support.

1:8 Initiates one inflation-deflation cycle for every eighth cardiac cycle. Generally used to wean patient from IABP support.

9. Balloon Volume

a. When the IAB is plugged into the pump, the volume will automatically be set at full balloon size. To change volume:

1. Press pump OFF to change volume. (with 1.28 or higher software, pump may remain in ON position to change volume)
2. Press BALLOON VOLUME key.
3. Select INCREASE/DECREASE until desired volume is displayed. Press FULL VOLUME to return to volume based on balloon connector.



Balloon Volume (1.28 or higher Software)

The A*CAT*®1 SERIES 1.28 or higher software allows the user to set the precise volume to be delivered to the IAB in 0.5 cc increments. Volume can be changed while the pump is OFF or during pumping. If IAB volume is changed while pumping, the pump will pause for 1 or 2 beats to reset the volume and then resume pumping at the new volume setting.

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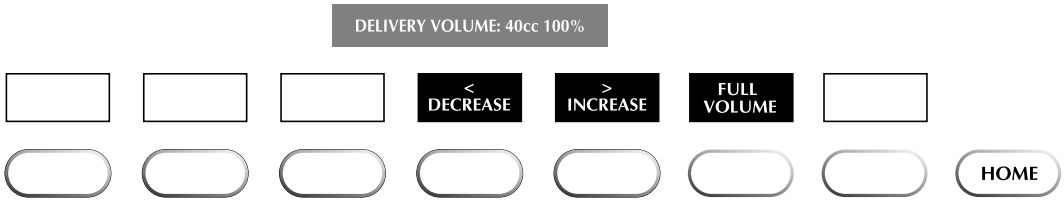
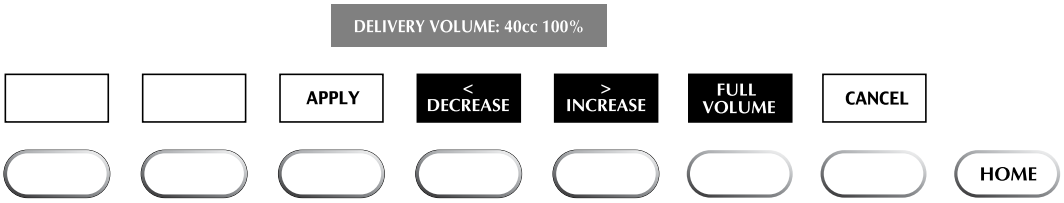
Changing IABP Delivered Volume

Change Volume:

1. Press BALLOON VOLUME key.
2. INCREASE or DECREASE the volume to the desired setting.
3. Press APPLY to change volume. NOTE: Pump will reset volume in 1 or 2 beats and resume pumping.
4. If volume change was made in error, press CANCEL or wait 30 seconds for multifunction keys to time out.



When < DECREASE or >INCREASE keys are pressed, the APPLY and CANCEL keys will be displayed

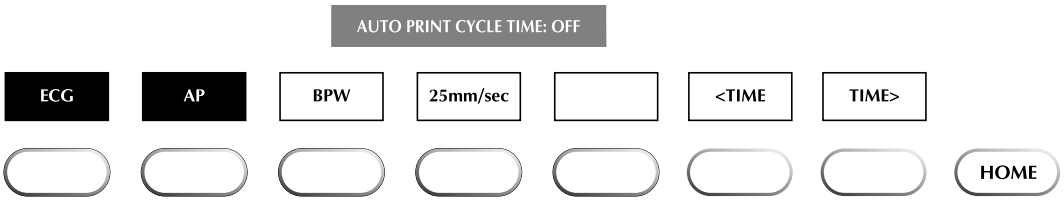


10. Recorder

a. Starts and stops recorder.

b. To change recorder settings:

1. Press HOME
2. Press RECORDER SETUP
3. Select desired waveforms or set recorder automatic print interval.



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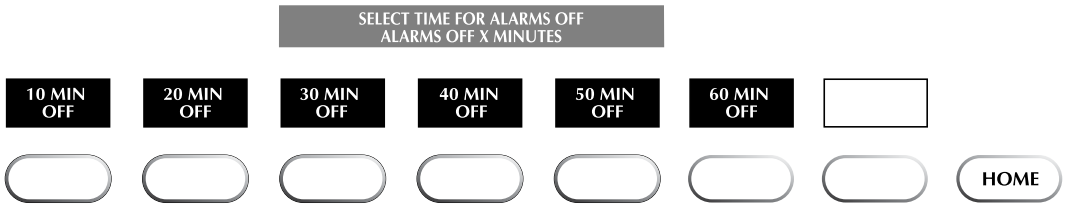
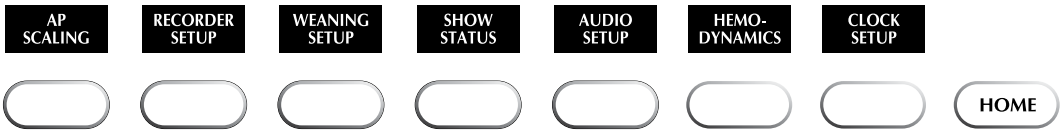
11. Alarm Control

a. RESET
Silences the audible alarm tone and clears the alarm message. If pumping was interrupted, the alarm message is not cleared until STNDBY or ON is pressed. If there is more than one alarm condition, one message is cleared at a time.

b. ON/OFF
Turns pneumatic alarms audio, recording, drain and refill on or off. To select alarm time off, press key under desired setting. Alarm message will be displayed. Time remaining for alarms off is displayed above AP Scale. Press ON/OFF again to reactivate gas surveillance alarms.



12. Home



a. AP SCALING
Selects AP Scale for display and recorder

b. RECORDER SETUP
Selects waveforms to be recorded. Time interval for automatic recordings may be set.

c. WEANING SETUP
Allows user to select volume, assist ratio and timer for weaning.

d. SHOW STATUS
This key will display a summary of all current operational settings as well as selected information which is tracked by the A*CAT*®1 PLUS.

e. AUDIO SETUP
Allows the user to set the key volume and turn it on/off and independently set alarm volume.

f. HEMODYNAMICS
Automatically calculates: PDP - PSP PDP - EDP

g. CLOCK SETUP
Allows the user to set the time and date for the pump.

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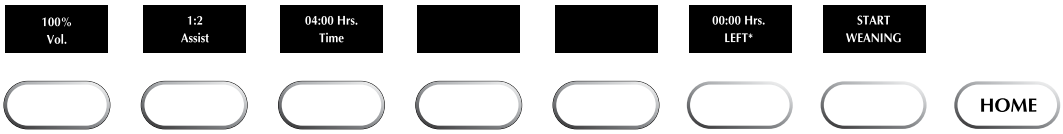
New Functions (1.28 and higher)

a. Hemodynamic Calculations and Charting Hemodynamic Values

To stabilize AP values for charting and show Unassisted AP values if available:

1. Press HOME
2. Press HEMODYNAMICS key
3. AP values will freeze for 30 seconds and if assist ratio is 1:2 or lower the unassisted values will appear in YELLOW, below the assisted AP values.
4. Press HEMODYNAMICS key again to unfreeze or wait 30 seconds.

13. Weaning Setup/Start



a. To begin weaning:

1. Press HOME
2. Press WEANING
3. Set Volume, assist ratio and time to desired settings.
4. Press START to implement weaning.

b. WEANING STEP COMPLETE:

When the timer expires for a weaning step, a Class 3 alert will be displayed:

WEANING STEP COMPLETE
EVALUATE HEMODYNAMICS AND CONTINUE
WEANING OR RESUME FULL IABP SUPPORT

Current IAB volume and assist ratio from the weaning setup will be used for pumping until another weaning setup is selected or until pumping is discontinued.

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c. WEANING AND INTERNAL TRIGGER MODE

Weaning cannot be set when INTERNAL trigger mode is selected. The user must change to another trigger mode if the weaning mode is required.

If you are in weaning and the INTERNAL trigger mode is selected and confirmed by pressing the INTERNAL key twice, weaning will be suspended and the INTERNAL mode will be selected.

d. CANCELING WEANING

To cancel a current weaning session:

1. Change assist ratio. IAB volume will return to FULL VOLUME at the new assist ratio.
2. Change IAB volume. Assist ratio will return to 1:1 at new IAB volume.
3. Press 100%V @ 1:1 key to initiate FULL VOLUME at 1:1 assist ratio.

14. Flash Card (1.28 or higher Software)

The A*CAT*®1 SERIES has the ability to customize the start up settings of the pump using a Flash Card. This Flash Card may be changed by the clinician to suit individual or institutional preferences. The following section is a guide to the use and programming of the Flash Card.

a. STARTING THE SYSTEM USING FLASH CARD SETTINGS

1. Place Flashcard in receptacle
2. Power ON
3. Selected settings will be in use.
4. Verify message that Flashcard settings are in use.

b. RETURNING TO A*CAT*®1 PLUS PRESET START UP SETTINGS

If the user prefers to return to the A*CAT*®1 PLUS Preset start up settings:

1. Press HOME
2. Press SHOW STATS
3. Press PRESET SETTINGS key x2.

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c. Preset start-up settings are:

Pump:	OFF
Assist Ratio:	1:2
ECG:	Skin, Lead II, Autogain ON
AP:	Transducer, Scale 50 - 150 mmHg
Trigger Mode:	Pattern
Timing settings:	Inflation 50% and Deflation 85% (Pattern trigger)
Alarms:	ON
Balloon Volume:	Full volume based on IAB connector
Recorder:	ECG/AP @ 25 mm/sec.
Cursor:	Top of Arterial pressure waveform
AP Alarm:	OFF

d. SAVING SETTINGS TO THE FLASH CARD

Verify that the Flash Card is NOT write protected. (A small switch is located on the end of the Flash Card opposite the connector. See the reverse side of the Flash Card for write protect position.)

1. Place Flash card in receptacle
2. Select start-up settings using the keys on the keypad and HOME multifunction keys.
3. When all settings are complete, Press HOME
4. Press SHOW STATS
5. Press SAVE TO FLASH key x2. Settings will now be saved.

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An alarm may cause the pump to stop pumping. The pump will display a message on the screen to assist in troubleshooting.

Once the condition is corrected, to resume pumping:

1. Press alarm RESET (until the reset LED is off) It may take several key presses if there are multiple alarms.
2. Press pump ON

If the alarm reappears consistently, refer to the Operator's Manual for further information.Or call the Arrow IABP support line at:800-447-IABP

1. Class 1 Alarms (Automatic Response)

The following Class 1 automatic response alarms cause the *ACAT*®1 PLUS to:

1. Stop pumping (PUMP OFF key illuminates)
2. Deflate the balloon
3. Open the vent valve
4. Initiate the audio alarm
5. Display an alarm message
6. Freeze the waveform display
7. Print approximately the last ten seconds of balloon and AP waveforms on the strip chart recorder

Note: Alarms must be reset prior to initiating counterpulsation.
The LED illuminated on the RESET key indicates alarm to be reset.
Depress the key until the LED goes out.

ALARM	POSSIBLE CAUSE	CORRECTIVE ACTION
Possible Helium Loss	Leak in tubing or connections	Perform Leak Test and repair tubing as needed
	Kinked Catheter	Find kink and straighten out the catheter. Be sure that the IAB membrane has fully exited the insertion sheath.
	Balloon connector not properly seated	Reconnect the balloon connector to console
	Blood in catheter tubing	Remove balloon immediately and insert a new IAB catheter WARNING: Any evidence of blood leakage within the IAB assembly warrants immediate IAB removal
Large Helium Loss Detected	Leak at catheter connection or tubing between console and catheter insertion point	Check all connection points for leaks and correct as required.
	Other Helium leak	Perform Leak Test and repair as necessary

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Class 1 Alarms (Automatic Response) – continued

ALARM	POSSIBLE CAUSE	CORRECTIVE ACTION
Unable to Refill **Version 1.28 or higher software** **(Replaces HE Loss 1 alarm)**	Low HE tank pressure	Verify HE tank is ON and has adequate HE supply. If HE tank pressure is less than 100 psi or HE tank display is RED, change tank.
	Timing settings are too wide for current heart rate and/or rhythm	Adjust timing settings to proper timing. Change trigger mode to PEAK or AFIB.
	Fill valves not functioning correctly	Change to another console. Call Field service.
	Tubing disconnection	Check tubing for disconnects and reconnect.
	Very large HE leak	Check for blood in tubing, if blood is found, stop counterpulsation and remove IAB. Assess for large leak in tubing or connections. Repair as directed on page 9-20 of the ACAT®1 PLUS Operator's Manual.

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Class 1 Alarms (Automatic Response) – continued

ALARM	POSSIBLE CAUSE	CORRECTIVE ACTION
Purge Failure	Helium tank not inserted properly	Reinsert tank per instructions.
	Helium tank empty	Replace with full helium tank
	Quick connect not connected or loose	Tighten or connect Quick Connect.
	Reliable trigger signal lost	Adjust ECG GAIN to reestablish triggering. Check electrode contacts. Change trigger mode. Check for broken electrical connections on electrodes and leads. Check to make sure the correct trigger source is selected. Select another trigger mode to obtain reliable triggering. Check the patient.
	Balloon not connected to the console	Connect balloon to BALLOON CONNECTOR on patient interface panel
High Baseline	Kinked catheter	Find kink and straighten out the catheter. Be sure that the IAB membrane has fully exited the insertion sheath.
	Partially wrapped balloon	Notify physician: aspirate to check for blood then inject approximately 10cc of air greater than the balloon volume into the balloon connector and aspirate immediately.
	Overfill	Call Arrow Service
	IAB not exited sheath	Be sure that the IAB membrane has fully exited the insertion sheath. Check to be sure proximal end of IAB is not in sheath.
High Pressure	Kinked Catheter	Find kink and straighten out the catheter.
	Partially wrapped balloon	Be sure that the IAB membrane has fully exited the insertion sheath. Notify physician: aspirate to check for blood then inject approximately 10cc of air greater than the balloon volume into the balloon connector and aspirate immediately.
	Balloon too large	Decrease IAB volume until the balloon pressure waveform returns to normal configuration. WARNING: The inflation volume should be no less than 2/3 of the balloon's capacity.
System Error	Fault in System	Press the ALARM RESET control key: press the PUMP STNDBY control key, then PUMP ON (correcting this alarm may require turning the power off and on to reset the microprocessor). All control key settings are retained in memory for five minutes and need not be reset. If the alarm recurs, call Arrow service.

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2. Class 2 Alarms (Automatic Response)

The following Class 2 automatic response alarms cause the A*CAT*®1 PLUS to:

1. Stop pumping (PUMP STNDBY key illuminates, system not vented)
2. Deflate the balloon
3. Initiate the audio alarm
4. Display an alarm message

NOTE: Trigger loss alarms will automatically reset and pumping resumes when trigger is established.

ALARM	POSSIBLE CAUSE	CORRECTIVE ACTION
ECG Trigger Loss	No ECG Waveform displayed	Check patient rhythm. Check electrode placement and change if necessary Check cable connections; reconnect if necessary Check external monitor connections at monitor and at pump input. Check lead selection. Check patient. Check ECG source selection, change if necessary.
	Waveform erratic or noisy	Reapply electrode paste or replace disposable electrodes.
	Low waveform amplitude	Select another lead (if using external monitor, use monitor's controls to select a different lead.
	Inapropriate trigger mode	Select another trigger mode (reassess timing).
ECG Lead Fault Detected	Poor electrode contact	Reapply electrode paste or replace disposable electrodes.
	Loose cable connections	Check cable connections; repair if necessary. Replace ECG Cable.
Pressure Triggering Loss	No pressure waveform	Check patient's state Check all connections Check pressure transducer, catheter and all connections for loose connections; repair if necessary Make sure that correct pressure source is selected. Select another trigger mode (reassess timing).
STANDBY longer than 3 minutes	Pump was left in STANDBY status for longer than 3 minutes	Press PUMP ON to resume pumping. Press PUMP OFF to stop pumping. Press ALARMS RESET to continue STANDBY for additional 3 minutes (may repeat). Press PUMP STNDBY twice within 30 seconds to bypass this alarm
STANDBY alarm off	Pump was left in STANDBY status and STANDBY alarm was bypassed	Press PUMP ON to resume pumping. Press PUMP OFF to stop pumping. NOTE: This alarm does not have audio tone.

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3. Class 3 Alarms (Automatic Response)

The following Class 3 (information only) alarms alert you to less serious conditions. You should check on the condition, but immediate action may not be required. Class 3 alarms cause the *ACAT*®1 PLUS to:

1. Initiate the audio alarm
2. Display a visual alarm message on the display.

ALARM	POSSIBLE CAUSE	CORRECTIVE ACTION
Deflation > 100%	Deflation set beyond 100% of R-R interval	Check timing in relation to AP waveforms; adjust if necessary.
Drain Failure	Condensate collection bottle full or tubing is kinked Drain valve failed to open or system purge not performed	Empty condensate collection bottle. Straighten tubing. Initiate purge cycle by pressing PUMP OFF, then PUMP STANDBY; wait 5 seconds for purge, then press PUMP ON to restart pumping. Call Arrow for service
Battery life less than 20, 10, 5 minutes	Battery will be completely discharged in 20, 10, 5 minutes	Connect system to AC power as soon as possible to charge batteries
System running on batteries	System accidentally or intentionally disconnected from AC power AC power failure	Reconnect system to AC power as soon as possible. Arrange for alternate AC power source if failure expected to exceed battery life.
Battery Inoperative	The system will not run in battery mode due to the faulty circuit breaker	Do not disconnect the system from the AC power source. Check the DC circuit breaker located in the helium compartment.
Timing Error	Insufficient time to deflate before next inflation cycle	Check timing in relation to AP waveform; adjust as necessary
ECG waveform detected in internal trigger	Patient has ECG complex	Verify ECG, change trigger mode
Low Helium Supply	Helium tank pressure less than 100psi. Helium tank inserted improperly	Install a full helium tank. Remove and replace helium tank per instructions
Low battery for static RAM	The internal RAM battery needs to be replaced	Place service call
AP ALARM LIMIT (Version 1.28 or higher software)	AP disconnect AP pressure has dropped AP alarm limit set too high	Check AP lines for disconnection, reconnect and reflush Assess patient condition and treat according to hospital protocol. Change AP alarm limit. Change AP alarm limit
WEANING STEP COMPLETE (Version 1.28 or higher software)	Weaning timer has expired	Assess patient hemodynamics and set next step of weaning. Press START WEANING. If hemodynamic status is unstable, resume full support by pressing the 100%V @ 1:1 key X 2 or increasing IAB volume and/or assist ratio.

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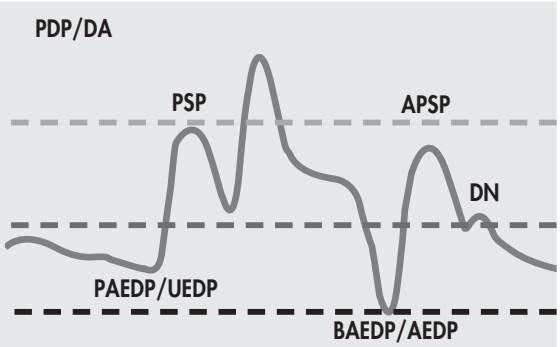
4. Timing Guidelines

The Timing Three

1. Inflation
   GOAL: To produce a rapid rise in aortic pressure (optimize PDP/DA), thereby increasing O_2 supply to coronary circulation
   a. Inflate just prior to DN which should result in PDP/DA>PSP
2. Deflation
   GOAL: To reduce aortic end diastolic pressure (afterload), thereby decreasing MVO_2 while improving the CO (cardiac output).
   b. BAEDP/AEDP<PAEDP/UEDP
   c. APSP < PSP

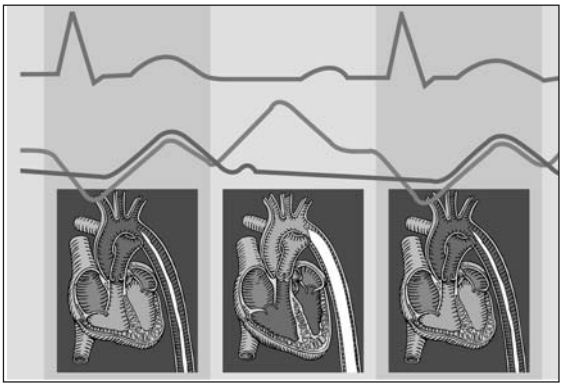


Assisted Arterial Waveform (1:2)

Abbreviation	Definition
PAEDP/UEDP	Patient Aortic End Diastolic Pressure
PSP	Peak Systolic Pressure
PDP/DA	Peak Diastolic Pressure/Diastolic Augmentation
BAEDP/AEDP	Balloon Aortic End Diastolic Pressure
APSP	Assisted Peak Systolic Pressure (Systole after IAB deflation)
DN	Dicrotic Notch

Balloon Inflation and Deflation

Electrical and mechanical Relationship



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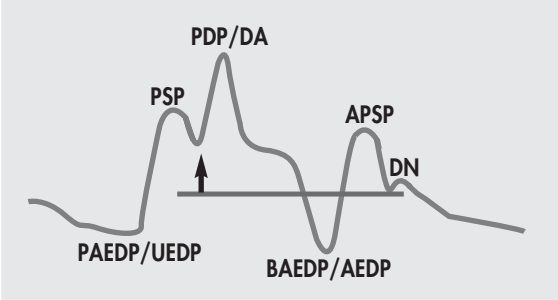
Incorrect Timing States

1. Early Inflation

   IAB is inflated well before actual DN. (aortic valve closure.) Violates Rule 1 for inflation.

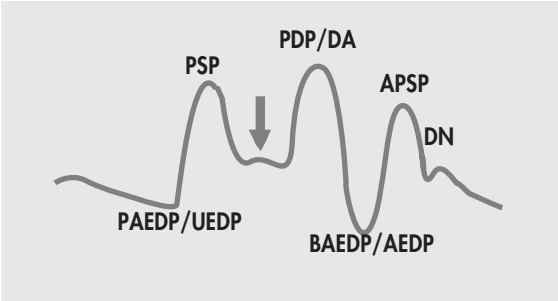
   Result: Premature closure of aortic valve. Reduces stroke volume/CO. Increase in LVED volume.



2. Late Inflation

   DN is visible between points PSP and PDP/DA. Violates Rule 1 for inflation.

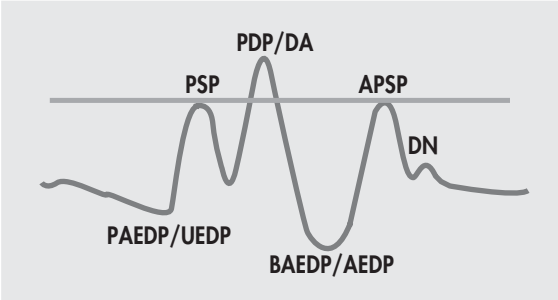
   Result: PDP/DA less than optimum. Decreased perfusion pressure and volume to coronary arteries.



3. Early Deflation

   APSP = PSP Violates Rule 3 for deflation. May see "U" shape at BAEDP/AEDP.

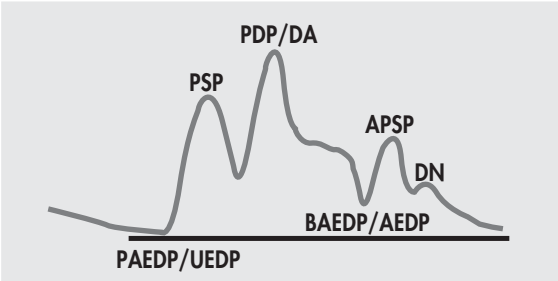
   Result: No afterload reduction.



4. Late Deflation

   BAEDP/AEDP > PAEDP/UEDP Violates Rule 2 for deflation.

   Result: Increased workload of left ventricle. Increased MVO^2. Decreased CO.



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5. Recommended IABP Triggers

RHYTHM	PATTERN R-wave criteria: 25-135msec.	PEAK Wide Complex QRS	AFIB Varying R-R Automatic R-wave deflation	V-PACE[1] 100% Paced	A-PACE[1] 100% Paced	AP (Consistent BP)	INT Rate 80 automatic Range 40-120
NSR	*	*	*[4]			*	
S Brady	*	*	*[4]			*	
S Tachy	*	*[5]	*[4]			*	
Cautery Interference						*	
NSR With premature beats	* (atrial)[2]	* (vent)	*				
NSR with pauses	*	*	* if severe			*	
PAT/SVT	*	*				*	
Atrial Flutter	*	*	* if irregular				
Atrial Fibrillation	*[3]	*	*				
Atrial Pacing	* demand	* demand			* 100% Paced	*	
Ventricular Pacing		* demand		* 100% Paced		*	
A-V Pacing		* demand		* 100% Paced		*	
RBBB, LBBB		*				*	
Ventricular Tachycardia		*				*	
CPR						*	*
Bypass-Pulsatile Flow System Test							*

[1] Note: No capture beat needed for trigger.
[2] Depends on type and number of premature beats.
[3] For significant irregularity use Peak.
[4] If real time timing desired.
[5] May be preferred for HR > 140 bpm.

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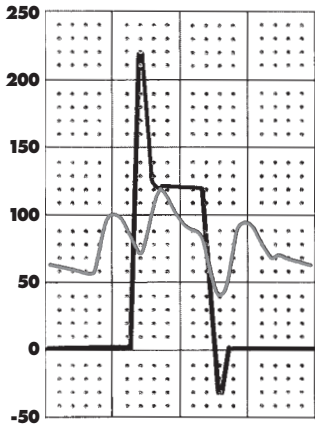
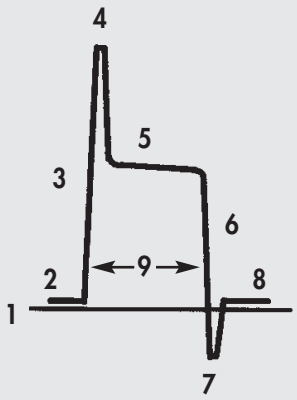
6. Balloon Pressure Waveform



1. Description
   The Balloon Pressure Waveform (BPW) represents helium movement from the console to the IAB catheter. It is shown as a calibrated, continuous waveform which allows objective assessment of the safety and effectiveness of counterpulsation.
2. BPW Height
   Reflects the pressure in the aorta, therefore the plateau pressure on the BPW should be within ±20mmHg of the DA/PDP.
3. BPW Width
   Is approximately the duration in which the balloon is inflated.

1. Zero Baseline
2. Balloon Pressure Baseline
3. Rapid Inflation
4. Peak Inflation Artifact
5. Plateau Pressure
6. Rapid Deflation
7. Deflation Artifact
8. Return to Baseline
9. Duration of Balloon Cycle



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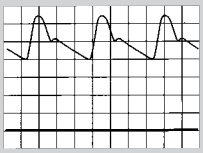
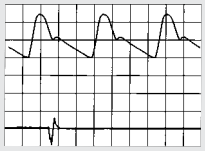
Balloon Pressure Waveform (continued)



Purge Failure

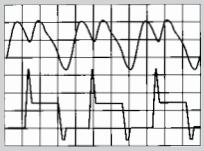
Check for:
- Loss of trigger



Purge Failure

Check for:
- Leaks
- Low helium

Reduced Augmentation



Low Plateau Pressure

Check for:
- Volume setting too low
- Balloon too small for patient
- Balloon too low in aorta
- Low systemic vascular resistance

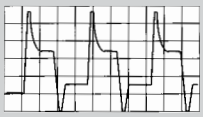
Poor Augmentation

Wide Inflation and/or Deflation Artifact

Check for:
- Proximal portion of IAB in sheath
- Suture too tight around catheter
- Partial obstruction
- Partial kink
- Slow catheter or He shuttle speed
- Very tortuous vessels

Wide deflation artifact may cause Possible Helium Loss Alarm in 1:1 assist.

Baseline Elevated



High Baseline

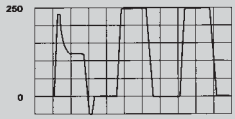
Check for:
- Kinked catheter
- Partially wrapped balloon
- IAB in sheath
- IAB too low in aorta
- IAB too large
- Overfill

Baseline Below Zero

Possible Helium Loss

Check for:
- Blood in catheter tubing
- Possible leak in connections or tubing
- Kinked catheter
- Ectopic beats

Squared or Rounded Plateau Pressure



High Pressure

Check for:
- Partially wrapped balloon
- Kink in catheter or tubing
- Balloon too large for aorta
- Balloon position too high or too low
- Balloon in sheath

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Skills Checklist

Name_____

Date _____

Instructor_____

Skill	DEMO DATE	INITIALS
1. Initial Set Up		
A. Power Up		
B. Connect Patient ECG		
1. Skin		
2. Phono-Phono		
C. Adjust ECG Gain, If Necessary		
D. Connect Arterial Pressure		
1. Phono-Phono		
2. Transducer		
E. Initiate 4 Beat Purge		
F. Initiate Pumping		
2. Timing, Identify And Correct		
A. Early Inflation		
B. Late Inflation		
C. Early Deflation		
D. Late Deflation		
3. Change Assist Interval		
4. Recorder		
A. Program:		
Waveform 1		
Waveform 2		
Date/Time		
B. Change Paper		
5. Zero Arterial Pressure Transducer		

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Skill– (continued)	DEMO DATE	INITIALS
6. Change Arterial Pressure Scale		
7. Activate Appropriate Trigger For: A. Clear ECG, QRS Normal, Rate 90 B. Clear ECG, QRS Wide, Rate 110 C. Noisy ECG With Excessive Interference D. A.V. Sequential Pacemaker-Fixed Rate E. Atrial Pacemaker-Fixed Rate F. Rapid, Irregular Rhythm G. Cardiopulmonary Bypass		
8. Alarms A. Assure Alarms On. If Not, Turn On B. Reset Alarms When Activated And Resume Pumping		
9. Change Helium Tank		
10. Initiate Battery Operation		
11. Empty Water Drain		
12. Adjust Balloon Volume		
13. Assess IAB Sizing Relative to Patient's PDP		

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____ 1. The landmark on the arterial pressure waveform used to time the inflation point is

A. The dicrotic notch

B. The systolic peak

C. The end diastolic pressure

D. Diastolic augmentation

____ 2. A physiological effect of early inflation of the balloon may be

A. Potential premature closure of the aortic valve

B. Suboptimal diastolic augmentation

C. Potential retrograde coronary and carotid blood flow

D. Potential renal artery hypoperfusion

____ 3. The waveform characteristics of late inflation includes

A. Inflation prior to the dicrotic notch

B. Diastolic augmentation encroaches into systole

C. Rate of rise of assisted systole is prolonged

D. Inflation of the balloon after the dicrotic notch

____ 4. A trigger is defined as

A. Adjustment of inflation and deflation

B. Pressure exerted to inflate IAB

C. Event that purges console automatically

D. Signal to identify the onset of the next cardiac cycle

____ 5. The trigger of choice on the A*CAT*®1 PLUS pump is

A. AP (arterial pressure)

B. Peak

C. A Pace

D. Pattern

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____ 6. Your patient is 100% A-V paced. What is your first trigger choice?

A. AP (arterial pressure)

B. Pattern

C. Peak

D. V Pace

____ 7. The following represents a cause of a HELIUM LOSS alarm

A. Kinked line

B. IAB abrasion

C. IAB malpositioned

D. All of the above

Answers:

1. A
2. A
3. D
4. D
5. D or B
6. C
7. D

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Intra-Aortic Balloon Pumping
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